

LETTERS TO THE EDITOR.

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The Structure of the Inner Corona.

It was my good fortune to observe the total eclipse of 1878 at the very exceptionally favoured station of Pike's Peak, at an elevation of 14,000 feet, and in the clearest air.

Having a few months earlier, on the occasion of the transit of Mercury, of May 6, been enabled to see the planet *before* it reached the sun's limb, owing to its projection on the background of the inner corona, I was greatly impressed by the brightness of the latter close to the sun, and though unable to give it more than a few seconds' visual observation during the eclipse, this was done with a five-inch achromatic, with a magnifying power of 72, which, so far as I know, gave the earliest intelligence of the extraordinary structure which obtains there.

I quote from my report addressed to the Superintendent of the United States Naval Observatory, and published in the *Annals of the Observatory for 1876* (Appendix iii. p. 209):—

"What I saw thus momentarily was not in the least what I expected. If there were any structure in the very inner corona, it had escaped me when I had searched for it in a previous eclipse (at Jerez, in 1870). It is true that the sky was hazy on that occasion, and that on this it was exquisitely clear. Now what I saw in this brief view was a surprisingly definite filamentary structure, somewhat coarser and decidedly more sharply defined than I have ever seen filaments in the photosphere, not disposed radially, or only so in the rudest sense, sharpest and much the brightest close to the disc, fading rapidly away into invisibility at a distance of five minutes of arc or more (possibly in some cases of ten). The salient point to me was this very remarkable definiteness and precision of these forms, and this impression, made on my mind in that too brief moment, is reproduced in this sketch (*not here given*), taken from one made within ten minutes of the event. It is in no way a 'picture,' but a reproduction of the original memorandum of the first impression of the features of the (telescopic) inner corona, which were, to repeat: (1) Extraordinary sharpness of filamentary structure; (2) arrangement not radial, or only so in the rudest sense; (3) generally curved, not straight lines; (4) curved in different directions; (5) *very* bright close to the edge, and fading very rapidly,—fading out wholly at from five to ten minutes from it."

If I can trust to this memorandum of an observation which, however brief, was made under uniquely favourable circumstances, and to my own recollections, I should say that while most interesting photographs of the inner coronal structure have recently been made, yet that this feature has not yet been done justice to even in the best of them I have seen, and that it perhaps cannot be, with our present means. While trusting then that at the coming eclipse it will be a prominent subject for every party with an adequate photographic outfit, I beg to express the hope that wherever possible it may be made the subject of telescopic visual study.

S. P. LANGLEY.

Smithsonian Institution, Washington, February 23.

Suggested Source of the Energy of the "Becquerel Rays."

In view of the difficulties arising in supposing that the energy to produce the photographic, ionising and phosphorescent screen effects with the "Becquerel Rays," continuously emanates from the active substance, I would suggest that the possibility should be kept in view of the real source of the energy being found in the things themselves in which these effects are manifested.

From this point of view the emanating influence would be looked upon rather in the light of lines of force than as a wave propagation; and, indeed, up to the present we have no conclusive evidence that the effects are those of waves.

The ionising power is especially suggestive, and considered in connection with other known ionising effects through molecular distances, may well be only the case of similar

action taking place over greater distances, corresponding to centres of greater molecular mass, such as the atomic weights of those up to the present observed active substances possess. The effect would then be viewed as due to what might be called a Becquerel field of force, arising it may be from some strained condition of the ether directly accompanying the existence of material molecules, or through the intermediary action of molecular chains. In this connection, as well as on account of the magnetic deflection, it would be important to know if the action takes place through a really high vacuum.

From this view the active substance need not lose in power with time, and so long as fresh unused-up material to be acted upon is brought up there need be no cessation in the effects observed.

An observation of M. and Mdme. Currie that a phosphorescent screen ceased to afford illumination after a time, although the active substance continued to effect fresh screens is in agreement with this, as well as their further observation that the exhausted screen after exposing to light is again capable of being effected. Thus some of the energy, at least if not all, is apparently to be attributed to the screen.

The effect, then, would be looked on as one of chance alignment or directive selection in a field of force; advantage, so to speak, being taken of suitable molecular movements according as they occur in the effected matter.

From this point of view there would be a close analogy with the action which takes place in a piece of soft iron in the field of a permanent magnet. The process of gradual orientation of the molecules in the iron, while it is occurring, corresponding to, say, the luminous stage in the phosphorescent screen. The final stage of magnetisation corresponds to the exhausted condition of the screen.

If these suggested views were correct we might expect from the analogy that forces should exist between the acted-on substance and the source of the "Becquerel Rays."

FRED. T. TROUTON.

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A Possible Cause of the Variability of Stars.

IN our study of nature it is sometimes advantageous to speculate as to possible causes of observed phenomena in cases where we are not yet in a position to institute an investigation which would entitle us to have no doubt as to the true cause. The cause suggested by the speculation may possibly prove to be the true cause; and if not, it is at all events likely to bear a valuable analogy as regards the laws of its operation, with the mode in which the real cause operates.

Prof. George Darwin's theory as to the origin of the moon is one of the most striking examples of such a speculation; and it was on reading it some years ago that an application of the same principles of action to account for variable stars occurred to the present writer. He now publishes the speculation because it seems to offer a satisfactory explanation of some remarkable facts recently brought to light which have attracted much attention, viz. that as many as forty stars of the Cluster Messier V., nearly one-twentieth of all the stars in the cluster, have been found to be variables possessing periodic times, light-curves, maxima of brightness, and minima of brightness, which, though not the same, do not differ much from one star to another.

As an introduction to the explanation which is about to be suggested, it will be convenient to refer to a very early experience of the writer. Potatoes used formerly to be boiled in open pots over a naked fire, and a phenomenon then presented itself, which he often watched when a boy with wonder, until at length, to his satisfaction, he perceived the very simple cause to which it is due. The water at almost equal intervals of time swelled up, and a little boiled over; it then subsided and boiled more tranquilly. These phases were repeated with surprising regularity, making the whole a definite quasi-periodic phenomenon; although upon a closer scrutiny it was found that the intervals, while nearly, were not exactly equal, neither were the recurring phases of the phenomenon accurately alike. Further experience showed that this example of quasi-periodicity is not exceptional, but one of a great body of quasi-periodic phenomena which occur in nature. With one of them we are here concerned, viz. with that which goes through its evolutions upon our sun, and manifests its approximately periodic character in the eleven-year period of sun-spot frequency.

It is obvious that the movements and other events to which sun-spots are due would only need to become a good deal more energetic to render our sun a perceptibly variable star with a period of eleven years. Now, a cause which may perhaps render them more effective is this. According as the sun or other star shrinks, its sun-spot or star-spot period will presumably undergo some change; but it is very unlikely that this change will follow the same law as that which governs the progressive shortening of the period of natural pulsation within the entire mass of the star. Accordingly, at a certain epoch in the history of the star, the two periods may approximate to one another. Thereupon the events producing star-spots are likely to acquire augmented intensity, which may render the star a variable star for a long cosmical period; in fact, until further shrinkage shall have slowly destroyed the adjustment.

Nor is it necessary that the two periods—that of star-spot frequency and that of natural pulsation within the star—shall become identical. The fluctuations in the number and size of star-spots will probably become exaggerated whenever the two periods in question become related in other simple numerical ratios. Accordingly, a star in the whole course of its life-history may at more than one stage become a variable star, although the most conspicuous fluctuation of its brightness, and that which is represented by the simplest form of light curve,¹ will only occur when the periods become equal.

In Messier V.—the great cluster in Virgo—the evidence which is published by Prof. Bailey in the *Astrophysical Journal* of last November establishes the fact that at least forty of its stars, or nearly one-twentieth part of all the stars of the cluster, differ but little from one another in brightness, and exhibit other resemblances which indicate that these stars are now very much alike in their physical condition. It is, therefore, in a considerable degree probable that at a remote epoch in the past they were so nearly in the same physical condition as to have then had pretty nearly the same brightness, the same star-spot period, and the same period of internal dynamical vibration. This amount of resemblance between so large a proportion of the stars of the cluster will not seem improbable to any one with experience of the appearances of star clusters, in many of which a conspicuous feature is the very notable proportion of the stars which are of one or of some few definite magnitudes.

If then these forty stars were originally nearly alike, they would continue so during their subsequent history. They would all shrink in the same way, they would continue at each subsequent epoch to have nearly the same star-spot period, and also to have all of them approximately the same period of natural internal pulsation; and would accordingly all arrive nearly simultaneously at that stage when these periods approximate. They would then all of them become variables, and under precisely the circumstances which have been observed, viz. with the simplest form of light curve, and with some approach towards having the same maximum of brightness, the same minimum, and the same period of fluctuation.

It has been observed above that in the successive adjustments that may arise while a star is shrinking, some may be of a kind to lead to variability with more than one minimum in each cycle, while the principal adjustment (where the two periods become the same and not merely simply related) will have only one minimum in each cycle. Instances of both are presented by known variable stars; though naturally the second case is that which has been most noticed because it is, when it occurs, that the brightness of the star exhibits the most conspicuous range of fluctuation.

G. JOHNSTONE STONEY.

8 Upper Hornsey Rise, N., March 1.

A New *Peripatus* from New Zealand.

As the genus *Peripatus* is always regarded with exceptional interest by zoologists, I should like to make known through the medium of your column the discovery of a new and very beautiful species in the dense beech forest at the head of Lake Te Anau, in the South Island of New Zealand. I found it a few days ago in the decaying trunks of trees (presumably beech), and have since collected between twenty and thirty specimens. The species resembles the well-known *P. novae-zealandiae* in shape and size, but is at once distinguished both

¹ There is quite enough of correspondence between the light curve of those variable stars which have one minimum in each cycle, and the curve of sun-spot frequency, to create an appreciable presumption in favour of the speculation of the present paper.

from it and from the other New Zealand species, *P. suteri*, by the possession of only fourteen pairs of walking legs, and by the presence on the dorsal surface of fifteen pairs of green spots arranged segmentally, one pair over each pair of legs, and one pair over the oral papillae. The general coloration of the dorsal surface is dark grey mottled with orange, with a dark median band and a black or nearly black triangular patch between each two successive green spots on each side. There are also pale orange or whitish papillae, very regularly arranged. The ventral surface is mottled grey or violet, with pale areas between the legs. The antennae are grey, ringed with orange. One specimen is almost jet black on the dorsal surface except for the green spots. Adult females are at once distinguished by the presence of an elongated protuberance between the legs of the last pair. This organ is yellowish in colour and bears the genital aperture, closely resembling the ovipositor of the egg-laying Victorian species, *P. oviparus*. The males are rather smaller than the females, and have a white papilla at the base of each leg of the last nine pairs. I propose for this species the name *Peripatus viridimaculatus*.

Lake Te Anau, N.Z., January 14.

ARTHUR DENDY.

Notes on the Occurrence of *Amphioxus* at Singapore.

The following notes on the occurrence of *Branchiostoma belcheri*, Gray, at Singapore have been written at the suggestion of Dr. Arthur Willey, who has kindly examined and identified the specimens for me; they were collected by Mr. W. F. Lanchester and myself, and are, I believe, the first that have been obtained from the locality. The first indication we had of the presence of *Amphioxus* in the district occurred about the middle of November 1898, when a number of young examples were found amongst the material collected by tow-netting at the extreme surface of the water about one or two hours after sunset. At the time we were living on a small island about ten miles off Singapore, and we tow-netted every night just outside or over the edge of the reef surrounding the island. The tidal currents were generally very strong, and no doubt brought a considerable amount of the plankton from the deeper layers to the surface.

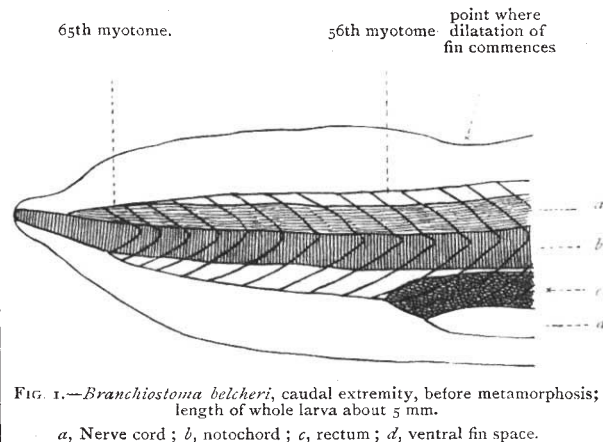


FIG. 1.—*Branchiostoma belcheri*, caudal extremity, before metamorphosis; length of whole larva about 5 mm.

a, Nerve cord; b, notochord; c, rectum; d, ventral fin space.

Up till the end of November (when we left the island) young *Amphioxus* continued to be fairly plentiful; but they were never met with elsewhere, and in June last year I visited the island again and could find no trace of them.

All these specimens were in different later stages, some having completed their metamorphosis, the fin-rays and ventral fin-chambers being already formed, while in others the gill-slits were still unilateral and opened freely to the exterior.

After the capture of the above examples we repeatedly dredged in the hope of obtaining adult examples, but on only one occasion were we successful, and then only a single specimen was found. It occurred in about six fathoms of water on a bottom composed of somewhat coarse gravel-sand close to the west entrance to Singapore Harbour. I am inclined to attribute our failure in securing more adults to the nature of the ground in which they live. With an ordinary dredge they could easily wriggle through the meshes, and the only time I tried a canvas-bag dredge it filled so rapidly with sand as to be quite useless.